

Technical Progress Report

For the Period:

July 1, 1991 through September 30, 1991

Prepared For:

**Rosebud SynCoal Partnership
Advanced Coal Conversion Process Demonstration
Colstrip, Montana**

**DOE Contract
DE-FC22-90PC89664**

Prepared by:

**Western Energy Company
Colstrip, Montana**

December 1991

For submittal to:

**United States Department of Energy
Pittsburgh Energy Technology Center**

LEGAL NOTICE

This report was prepared by Western Energy Company pursuant to a cooperative agreement partially funded by the U.S. Department of Energy and neither Western Energy Company nor any of its subcontractors nor the U.S. Department of Energy nor any person acting on behalf of either:

- (a) Makes any warranty or representation, express or implied with respect to the accuracy, completeness, or usefulness of the information contained in this report; or
- (b) Assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

The process described herein is a fully patented process. In disclosing design and operating characteristics, neither Western Energy Company nor Rosebud Syncoal Partnership release any patent ownership rights.

References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Department of Energy. The views and opinion of authors expressed herein do not necessarily state or reflect those of the U.S. Department of Energy.

Table of Contents

	<u>Page</u>
1.0 Introduction and Purpose	1
2.0 Project Progress Summary	2
3.0 Process Description	3
4.0 Technical Progress	8
4.1 Facility and Equipment Design Engineering and Procurement	8
4.2 Process Design Topics	10
4.3 Site Construction	12
4.4 Permitting	15
4.5 Facility Startup and Testing	16
4.6 Production and Product Testing	17
5.0 Problem Areas and Lessons Learned	18
6.0 Future Work Areas	18

1.0 Introduction and Purpose

This report contains a description of technical progress made on the Advanced Coal Conversion Process Demonstration Project (ACCP).

The project is a U.S. Department of Energy Clean Coal Technology Project. The cooperative agreement defining the project is between DOE and the Rosebud SynCoal Partnership (RSCP). The RSCP is a partnership between Western Energy Company (WECO), a subsidiary of Entech Inc., Montana Power Company's non-utility group, and NRG Inc., a subsidiary of Northern States Power.

This project will demonstrate an advanced thermal coal drying process coupled with physical cleaning techniques to upgrade high-moisture, low-rank coals to produce a high-quality, low-sulfur fuel. The coal will be processed through two vibrating fluidized bed reactors that will remove chemically bound water, carboxyl groups, and volatile sulfur compounds. After drying, the coal will be put through a deep-bed stratifier cleaning process to effect separation of the pyrite rich ash.

The process will enhance low-rank western coals, usually with a moisture content of 25-55%, sulfur content of 0.5-1.5%, and heating value of 5,500-9,000 Btu/lb by producing a stable, upgraded coal product with a moisture content as low as 1%, sulfur content as low as 0.3%, and heating value up to 12,000 Btu/lb.

The 45 ton/hr unit will be located adjacent to a unit train loadout facility at Western Energy Company's Rosebud coal mine near the town of Colstrip in southeastern Montana. The demonstration plant is sized at about one-tenth the projected throughput of a multiple processing train commercial facility. The demonstration drying and cooling equipment is currently commercial size.

2.0 Project Progress Summary

Design work is over 95% complete and construction is approximately 65% complete.

The piling contractor has completed work on the site; a total of about 26,415 liner feet of "H" pile has been driven along with about 17,900 square feet of sheet piling.

The slipformed concrete storage silos are nearly complete with only a small fraction of the lower sloped sections remaining to be erected.

Work on the substructure is also nearly complete. The main building foundation, infeed hooper concrete, conveyor bent foundations, and underground piping are complete. A total of about 11,650 cubic yards of concrete has been poured in construction activities to date with about 98% of the foundations completed.

The two steel silos were completed during the reporting period. A 1,000 ton raw coal storage silo and a 300 ton waste coal storage silo have been erected.

The structural steel contractor began site work in mid August 1991. Steel for the north half of the processing building was constructed first which is the coal drying and cooling areas. Approximately 450 tons of structural steel will be erected.

The mechanical contractor mobilized in late July 1991. Work began immediately in work areas that were available including the cooling water system, process heater, infeed area, fans, dryers, and coolers.

The electrical contractor mobilized in mid August 1991. Work began immediately in the electrical equipment room.

Work on the administration building continued during the reporting period. The foundation for the building and the steel and siding are complete. Interior finish work is in progress. The 6,600 square foot administration building contains the facility control room, electrical equipment room, warehouse, office areas, and crew change areas.

Facility startup and initial production is currently projected to occur before the end of the calendar year. The project is currently five weeks behind the partnership's accelerated schedule and about one year ahead of the cooperative agreement schedule. Costs are being carefully monitored and the project is currently within its budget.

3.0 Process Description

In general the ACCP is a drying and conversion process using combustion products and superheated steam as fluidizing gas in vibrating fluidized beds. Two fluidized stages are used to heat and dry the coal and one water spray stage followed by one fluidized stage is used to cool the coal. Other systems servicing and assisting the coal conversion system are:

- Coal Cleaning
- Product Handling
- Raw Coal Handling
- Emission Control
- Heat Plant
- Heat Rejection
- Utility and Ancillary

The central processes are depicted in Figure 3.1, the Process Flow Schematic.

Coal Conversion

The coal conversion is performed in two parallel processing trains. Each consisting of two 5-foot wide by 30-foot long vibratory fluidized bed dryer/reactors in series, followed by a water spray section and a 5-foot wide by 25-foot long vibratory cooler reactor. Each processing train is fed 1,139 pounds per minute of 2 x 1/2 inch coal.

In the first-stage dryer/reactors, the coal is heated using recirculated combustion gases, removing primarily surface water from the coal. The coal exists the first-stage dryer/reactors, at a temperature slightly above that required to evaporate water. The coal exists the first stage dryer/reactor and gravity feeds the second-stage dryer/reactors, which further heats the coal using a recirculating gas stream, removing water trapped in the pore structure of the coal, and promoting decarboxylation. The water making up the superheated steam used in the second stage is actually produced from the coal itself. Particle shrinkage that liberates ash minerals and imparts a unique cleaning characteristic to the coal occurs in the second stage.

As the coal exists the second-stage dryer/reactors, it falls through vertical coolers where process water is sprayed onto the coal to reduce the temperature. The water vaporized

[illegible]

WBS Inc.
ACAD#: A91M0435
REV: A DATE: 9/16/08
DRAFTER: DB

ROSEBUD SYNCOAL
ADVANCED COAL CONVERSION PROCESS
DEMONSTRATION PROJECT-PROCESS FLOW SCHEMATIC

during this operation is drawn back into the second-stage dryer/reactors. After water quenching, the coal enters the vibratory coolers where the coal is contracted by cool inert gas. The coal exits the cooler at less than 150 degree F and enters the coal cleaning system. The gas that exits the coolers is itself cooled by water sprays in contact coolers prior to returning to the coolers.

Three interrelated recirculating gas streams are used in the coal conversion system; one each for the dryer/reactors and one for the coolers.

Gases enter the process from either the natural gas fired process furnace or from the coal itself. Combustion gases from the furnace are used in the first-stage dryer/reactors after exchanging some heat to the second-stage gas stream. The second-stage gas stream is composed mainly of superheated steam. It is heated by the furnace combustion gases in the heat exchanger. The cooler gas stream is made up of cooled furnace combustion gases that have been routed to the cooler loop.

A gas route is available from the cooler gas loop to the second stage dryer/reactor loop. Gas may also enter the first-stage dryer/reactor loop from the second-stage loop (termed make-gas) but not directly into the loop; rather the make-gas is used as an additional fuel source in the process furnace. The final gas route is the exhaust stream from the first-stage loop to atmosphere.

Gas exchange from one loop to another is governed by pressure control on each loop, and after startup, will be minimal from the first-stage loop to the cooler loop and minimal from the cooler loop to the second-stage loop. Gas exchange from the second-stage loop to first-stage loop (through the process furnace) may be substantial because the water vapor and hydrocarbons driven from the coal in the second-stage dryer/reactors must leave the loop to maintain a steady state.

In each gas loop, upstream of the fans, are particulate removal devices to remove dust from the gas streams, protect the fans, and control emissions.

Coal Cleaning

The coal entering the cleaning system is screened into four size fractions: plus 1/2 inch, 1/2 by 1/4 inch, 1/4 inch by 6 mesh, and minus 6 mesh. These streams are fed in parallel to four deep-bed stratifiers (stoners), where a rough specific gravity separation is made using fluidizing air and a vibratory conveying action. The light streams from the

stoners are sent to the product conveyor; the heavy streams from all but the minus 6 mesh stream are sent to fluidized bed separators. The heavy fraction of the minus 6 mesh stream goes directly to the waste conveyor. The fluidized bed separators, again using air and vibration to effect a gravity separation, each split the coal into light and heavy fractions. The light stream is considered product; the heavy or waste stream is sent to a 300 ton storage bin to await transport to an off site user or alternately back to a mined out pit disposal site. The dry, cool, and clean product from coal cleaning enters the product handling system.

Product Handling

Product handling, consists of the equipment necessary to convey the clean product coal to two 6,000 ton concrete silos and to allow train loading with the existing loadout system.

Raw Coal Handling

Raw coal from the existing stockpile is screened to provide 2 x 1/2 inch feed for the ACCP process. Coal rejected by the screening operation is conveyed back to the active stockpile. Properly sized coal is conveyed to a 1000 ton raw coal storage bin which feeds the process facility.

Emission Control

Sulfur dioxide emission control philosophy is based on injecting dry sorbents into the ductwork to minimize the release of sulfur dioxide to the atmosphere. Sorbents, such as trona or sodium bicarbonate, will be injected into the first stage dryer gas stream as it leaves the first stage dryers to maximize the potential for sulfur dioxide removal while minimizing reagent usage. The sorbents, having reacted with sulfur dioxide, will be removed from the gas streams in the particulate removal systems. A 60 percent reduction in sulfur dioxide emissions should be realized.

The coal cleaning area fugitive dust is controlled by placing hoods over the sources of fugitive dust conveying the dust laden air to fabric filter(s). The bag filters can remove 99.99 percent of the coal dust from the air before discharge. All fines will report to a briquetter and ultimately the product stream.

Heat Plant

The heat required to process the coal is provided by a natural gas fired process furnace. This system is sized to

provide a heat release rate of 74 MM btu/hr. Process gas enters the furnace and is heated by radiation and convection from the burning fuel. Process make gas from coal conversion will be used as fuel in the furnace.

Heat Rejection

Most heat rejection from the ACCP will be accomplished by releasing water and flue gas to the atmosphere through an exhaust stack. The stack design will allow for vapor release at an elevation great enough that, when coupled with the vertical velocity resulting from a forced draft fan, dissipation of the gases will be maximized. Heat removed from the coal in the coolers will be rejected using an atmospheric induced-draft cooling tower.

Utility and Ancillary Systems

The coal fines that will be collected in the conversion, cleaning and material handling systems are gathered and conveyed to a surge bin. The coal fines will then be agglomerated and returned to the product stream.

Inert gas will be provided by cooling and drying combustion flue gases. This gas, primary carbon dioxide and nitrogen, will be used principally for baghouse pulse and for makeup gas in the cooler loop.

The common facilities include a plant and instrument air system, a fire protection system, and a fuel gas distribution system.

The power distribution system includes a 15 KV service, a 15 KV/5 KV transformer, a 5 KV motor control center, two 5 KV/480 V transformers, a 480 V load distribution center, and a 480 V motor control center.

Control of the process is fully automated including dual control stations, dual programmable logic controllers, and a distributed plant control and data acquisition hardware.

4.0 Technical Progress

4.1 Facility and Equipment Design Engineering and Procurement

During the reporting period, supply contracts were placed for the briquetter and briquette cooler. Table 4.1 lists the equipment supply contracts.

During the reporting period, work was completed on general arrangement drawings, piping and instrumentation drawings, foundation drawings, structural steel drawings, electrical drawings, and plant control system programming.

Significant manhours were expended by engineering and purchasing groups in expediting hardware delivery. Conveyor delivery, process ductwork, and structural steel erection were identified as critical path items and received special expediting attention.

Throughout the reporting period, plant equipment arrived on the construction site. Bucket elevators, coal cleaning equipment, silo mass flow gates, vibrating bin dischargers, air compressors, circulating fans, pumps, electrical equipment, main transformer, control valves, dampers, and dry sorbent injection system were all delivered in the reporting period. Partial shipments of the belt conveyors and dust collectors were also delivered.

Table 4.1 - ACCP Equipment Report

<u>Description</u>	<u>Contractor</u>	<u>Award Date</u>
Coal Dryers/Coolers	Carrier Vibrating Equip.	12/21/90
Belt Conveyors	Willis & Paul	04/01/91
Bucket Elevators	FMC Corporation	03/08/91
Coal Cleaning Equipment	Triple S Dynamics	01/25/91
Coal Screen	Hewitt Robins	12/21/90
Loading Spouts	Midwest International	05/13/91
Dust Agglomerator	Royal Oak	08/26/91
Briquetter Steel		
Silo Mass Flow Gates	SEI Engineers	04/01/91
Vibrating Bin Dischargers	Carman Industries	03/14/91
Vibrating Feeder	Kinergy Corporation	03/22/91
Drag Conveyor		
Process Gas Heater	G.C.Broach Company	01/25/91
Direct Contact Cooler	CMI-Schneible Co.	03/06/91
Dust Collectors	Air Cure Environmental	06/07/91
Air Compressors/Dryers	Colorado Compressor Inc.	03/06/91
Fire Pumps-Diesel	Peerless Pump	05/30/91
Forced Draft Fan	Buffalo Forge Co.	12/21/90
Pumps	Dresser Industries Inc.	03/07/91
Electrical Equipment-4160	Toshiba International	03/14/91
Electrical Equipment-LDC	Powell	03/15/91
Electrical Equipment-MCC	Siemens	03/14/91
Main Transformer	ABB Power Company	01/04/91
Control Panels	Utility Control & Equip. Co.	03/08/91
Control Valves	Applied Control Equipment	05/24/91
Plant Control System	GE Supply Co.	02/08/91
Cooling Tower	JL Herman & Marley	02/01/91
Dampers	Effox Inc.	05/01/91
Dry Sorbent Injec. System	NaTech Resources Inc.	04/19/91
Expansion Joints	Flexonics	05/23/91

4.2 Process Design Topics

The one portion of the facility remaining in the design stages is the dust agglomeration system.

Dust Handling and Agglomeration

Western coals and especially dried western coals tend to be relatively dusty. This is a very negative characteristic of the upgraded coal and has lead to skepticism and a lack of acceptance of the products in the utility market. The ACCP project team is committed to breaking the mold in this area and producing a product that can be handled with relative ease at the processing facility, in transit, and at the consuming facility.

Because of the gas streams passing through the coal in the driers, coolers, and cleaning equipment, the product coal is "dedusted" which is a positive aspect. The negative side is that a large quantity of dust (6-13 tons/hour) will be collected from the gas streams which must be handled in an economical fashion.

A commercial scale facility might use the dust as fuel in the heat plant. This option was not selected for the demonstration plant due to permitting concerns and the additional cost of a coal fired heat plant. The dust could also be sold as a fuel to an off-site customer. This option is being persued, but until firm data on production rate and dust characteristics is collected, reliable customers cannot be established and an alternate method of disposable is necessary.

Blending the dust back into the product coal stream or blending and selling the dust with raw coal are both unacceptable alternatives because of excessive problems with fugitive dust emissions while handling the coal.

Burying the dust in mined out pits of the mine is an option but is probably the least desirable both from an economical and resource conservation standpoint.

The only remaining alternative is to convert the dust into a more massive form also called agglomeration. An extensive study of coal dust agglomeration methods was conducted. Enough knowledge was gained to determine which of the methods were the most likely to be successful. Of the four general methods available (pin mixer, disk pelletizer, briquetter, and ring extruder), the products of only briquetters and ring extruders were judged to be strong enough to warrant further pursuit. A bid specification was generated and distributed to vendors. In addition, the option of purchasing used briquetters was explored.

In response to the request for equipment bid, the ring extruder manufacturer submitted a relatively competitive bid, but was eliminated based on a less-than-adequate sample of extruded coal dust that was returned with the bid. The briquetter manufactures were basically unresponsive to the request for equipment bid. A set of three used briquetters, were located, inspected, and two of the three were deemed adequate for use in the ACCP facility. The set of three briquetters were purchased at less than one tenth the cost of one new briquetter. Additional engineering and auxiliary equipment will be necessary to complete an operable system.

4.3 Site Construction

The piling contractor returned to the site in July to install 17 piles after exact locations for the piles were established. Five hundred eighty-seven H piles have been driven. After excess length was trimmed, a total of about 26,415 liner feet remained installed. In addition, about 17,900 square feet of sheet piling has been driven for use as retaining walls.

The slipformed concrete storage silos had reached full height at the end of the last reporting period. Work on the silos during the third quarter consisted first of transferring the roof beams which had made up part of the slip forms onto the now complete concrete walls. The concrete roof caps were formed and poured along with the outlet sections consisting of sloped steel sheets and pouring structural and fill concrete under and behind the sheets.

Work on the substructure continued throughout the reporting period. The remainder of the main building structure foundation, and the remainder of the infeed structure, along with fan and pump pedestals, miscellaneous conveyor bent foundations, and dust collector foundations were formed and poured.

A total of about 11,650 cubic yards of concrete has been poured in construction activities to date with about 98% of the foundations completed.

Work on the steel silos was completed during the reporting period. A 1,000 ton raw coal storage silo and a 300 ton waste coal storage silo have been erected.

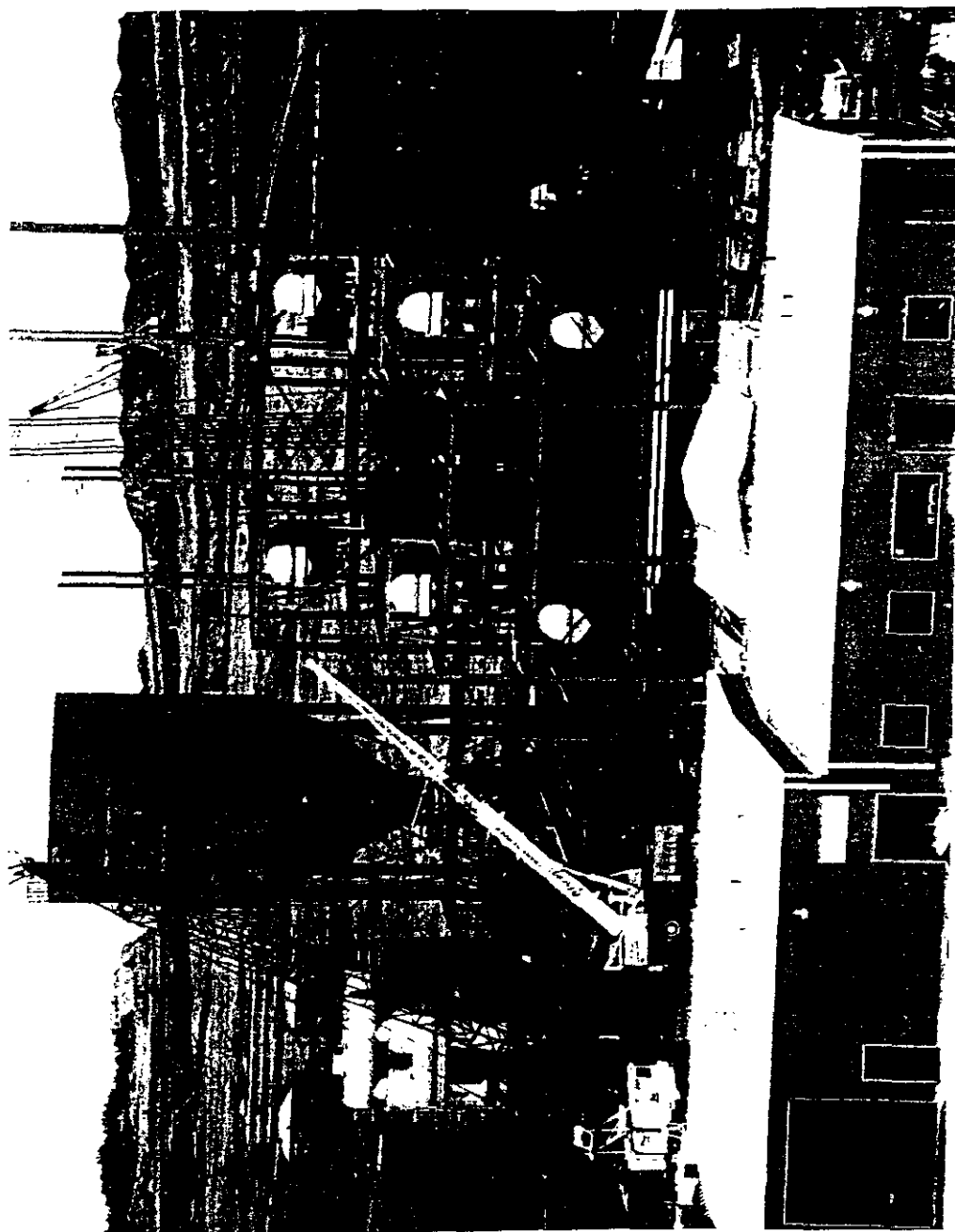
The structural steel contractor began site work in mid August 1991. Steel for the north half of the processing building was constructed first which is the coal drying and cooling areas. Approximately 450 tons of structural steel will be erected.

The mechanical contractor mobilized in late July 1991. Work began immediately in work areas that were available including the cooling water system, process heater, infeed area, fans, dryers, and coolers.

The electrical contractor mobilized in mid August 1991. Work began immediately in the electrical equipment room. Once the first level of structural steel was in place, work began in the processing building on cable tray.

Work on the administration building continued during the reporting period. The foundation for the building was completed

in early July followed by erection of the prefabricated building steel and siding along with insulation and interior work. The 6,600 square feet administration building contains the facility control room, electrical equipment room, warehouse, office areas, and crew change areas.



ACCP Construction Site
September 1991

4.4 Permitting

Approval of the request for an alteration to the existing air quality permit was received in July 1991.

A request for an alteration to the existing mine permit to allow deep-pit burial of the coal cleaning process slack is in processing at the Montana Department of State Lands. A request for further information was received in June 1991. Approval for this alteration is now expected in the fourth quarter of 1991.

4.5 Facility Startup and Testing

Initial operations of the facility are now projected for December 16, 1991. Initial startup will be performed by Stone and Webster Engineering.

As part of the initial production period, baseline testing of the process will be performed including compliance monitoring of the particulate removal systems. Preparation of a process test plan is underway. It will include performance tests on all process related equipment.

4.6 Production and Product Testing

Product production for 1992 is predicted to be 250,000 tons. The product will be sold to utilities and used in controlled test burns. Some initial test burn sales are already ensured. The process for test burns is being formulated and will include procedures for obtaining reportable data.

The supervisors for the hourly personnel were identified and the hiring process for the hourly personnel was begun.

5.0 Problem Areas and Lessons Learned

No major technical problems are known at this time.

Construction activities are currently about five weeks behind schedule. Excellent weather helped construction activities, but delays in delivery of material to the construction site negated the good weather advantage.

Coordination of information between vendors and the engineers has proved to be a problem area and delayed structural steel design and delivery along with equipment delivery.

6.0 Future Work Areas

Work continues on awarding facilitating and expediting contracts for equipment and construction. Operations and Maintenance (O&M) manuals will be written prior to startup. Methods of obtaining test burn data from the product coal will also be formulated before the end of the year.